Meat Demand Analysis in Urban China:
To Include or Not to Include Meat Away from Home?

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Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

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1. Introduction

The remarkable growth of corn and meat imports to China in recent years has attracted considerable attention of policymakers, industries, and research society to revisit meat demand in the country and its trend. While there is general consensus that Chinese is shifting from diets centered at staple of rice and wheat flour to one which incorporates more animal protein foods such as meat and aquatic product, it is noted that China has been able to secure its meat supply with a very high self-sufficient rates. The situation, however, has been slightly turning since 2009, when China turned from a net corn exporter into a net importer because of the strong demand for feed grain. In 2011, the annual import reached 5 MMT. Clearly, the increasing meat demand in China not only brings directly influences on the world meat market, but also affects feed use grain supply inside and outside of the country. Therefore, an improved understanding the changing meat demand and its trends can provide critical information in directing China's domestic meat and feed use grain production and international trade.

A better understanding of meat demand in China and its associated driving forces needs to take the remarkably growing dining out into consideration. Numerous studies from developed countries showed that household dining out increases significantly with income growth (Byrne et al. 1996, Mutlu and Gracia 2006). And, within the dining out consumption, meat accounts for comparatively higher proportion in volume than at home (Byrne et al. 1996). The increasing dining out consumption is also happening in China according to recent evidences (Ma et al. 2006, Min et al. 2004). This is especially true in urban areas given its incredible income growth over the last three decades and rapid development of market. According to Bai et al. (Bai et al. 2010), per capita expenditure on food away

from home (MAFH) in urban Beijing in 2007 was 163 Yuan in the survey month[1]. Therefore, without considering the dining out part, any estimation of income or expenditure elasticities of meat consumption and according projections could be severally biased (Bai et al. 2010, Ma et al. 2004, Zhong 1997).

Unfortunately, the existing literature examining food consumption in China gives little attention to meat consumption away from home (MAFH). Ma et al. (2006) found that income growth increase MAFH demand and affects the composition of expenditure. Households tended to spend more on meat and fish when they dine out than eat at home. Bai et al. (2010) studied Beijing urban household dining out expenditures by using their own survey data. They found that per capita monthly expenditure on dining out food consumption in the NBS survey data was approximately underestimated by one third. Despite on dining out consumption, both studies do not give specific attention to the meat demand. Much of other studies on food consumption in general actually focus on food at home consumption (Gao et al. 1996a, Huang et al. 1999, Guo et al. 2000, Fan et al. 1995, Gao et al. 1996b, Dong and Fuller 2010, Wang and Chern 1992) . The data they used are mostly from the National Bureau of Statistics of China (NBSC), which are believed neglecting the dining out part systematically (Bai et al. 2010, Ma et al. 2004). A couple of studies used macro-level data to estimate the income effects on household dining out expenditure (Min et al. 2004), their limitation in linking meat consumption into household characteristics and demographics are obvious.

In this study, we reexamine the meat consumption in China by adding MAFH into consideration. Our data are from recent diary-based household surveys conducted in six representative cities, with a wide geographic distribution in China, including Beijing, Nanjing, Chengdu, Xi'an, Shenyang and Xiamen. In the survey, the sampled households were asked to record the detailed information on food

[1] Per capita expenditure of 163yuan does not include the meal which was consumed by household members but not paid out of the family pocket. According to Bai et al. (2010), the estimated dinning out consumption hosted by other parties was valued 62 yuan per person a month in Beijing.

consumption eaten by the household member meal-by-meal, including at home and away from, for a whole week. Defining MAFH as all meat consumed by the household members but not prepared by the household, the current study will empirically examine how the exclusion of dining out could bias the estimation of explanatory variables, in particular, of income/expenditure effects. Over the past near three decades, China has successfully feed her over billion of population (22% of the world's population) with 7% of the world's farmland. Whether China will continuously being succeed in meeting the ongoing diet shift, however, remains unclear. By jointly considering meat consumption at home and away from home, this study can provide important evidence for the concern.

Also, the detailed information in our survey enables us to examine meat demand by type and to link meat consumption to household demographics. During the survey week, detailed information on household socio-economic characteristics and demographics, such as family composition, were also collected. Linking these variables to the observed meat consumption will help us identify the major driving forces of the meat demand patterns and structure changes.

Although using data from six major cities limits the ability to generalize our results nationwide, this study is still able to shed light on the understanding meat consumption in China and its trends. All six cities have long been both national and regional centers of education, economic, transport networks, and tourism. As a result, consumers' preferences in these cities have a significant influence in their regions in which they are located, as well as in the entire nation.

The structure of the paper is presented as follows. Section 2 presents the method and empirical model development, where we introduce a two-stage method of a censored quadratic almost ideal demand system (QUAIDS). Section 3 describes in detail the survey and the data construction. A price generation for meat consumption away from home is also briefed in this section. Section 4 discusses the

empirical results and demand elasticities. Section 5 concludes with major finding remarks and policy implications.

2. Two-Step Approach of a Censored System

Considering that income varies considerably across individual households and income elasticities differ across meat types, Banks et al. (1997) generalize the Almost Ideal Demand System (Deaton and Muellbauer 1980) by adding to it a squared income term. Specifically, the Quadratic Almost Ideal Demand System (QUAIDS) for the i^{th} good (i=1,…,*n*) is,

$$w_i = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \ln\left(\frac{M}{P}\right) + \frac{\lambda_i}{b}\left[\ln\left(\frac{M}{P}\right)\right]^2 + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \varepsilon_i \qquad (1)$$

where $b = = \prod_{i=1}^{n} p_i^{\boldsymbol{\beta}_i}$, $\ln P = \alpha_0 + \sum_{j=1}^{n} \boldsymbol{\alpha}_i \ln p_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \ln p_i \ln p_j$, $\alpha_0, \alpha_i, \beta_i, \lambda_i, \gamma_{ij}$ are parameters to be estimated, $w_i = p_i q_i / M$ is the budget share of good *i*, q_i is the quantity of good *i*, M is total expenditure, and ε_i is an error term with zero mean and constant variance. The adding-up restrictions on the parameters are $\sum_{i=1}^{n} \alpha_i = 1,\ \sum_{i=1}^{n} \beta_i = 0,\ \sum_{i=1}^{n} \lambda_i = 0,\ \text{and}\ \sum_{1=1}^{n} \gamma_{ij} = 0$, homogeneity may be imposed by $\sum_{j=1}^{n} \gamma_{ij} = 0$ and symmetry by $\gamma_{ij} = \gamma_{ji}\ \forall i, j$.

When data are complete or not censored, the QUAIDS may be estimated by maximum likelihood or iterative seemingly related regressions (SUR). However, if for some households, not all *N* goods are purchased, the problem of censoring occurs. Because the data used in this analysis was collected using household surveys, further discussed next, it is very common to observe zero values in consumptions. In empirical studies, zero consumption has important econometric and economic implications. The presence of zero consumption observations can be demonstrated as a positive probability that the choice happens at the kink or boundary points in choice sets of consumers (Lee and Pitt, 1986).

Statistical estimation procedures that do not account for non-negative in the dependent variable could lead to biased and inconsistent parameter estimates.

In order to solve the potential bias and inconsistency of non-negative parameters estimation, researchers commonly used some sort of corrections through estimation approach. Wales and Woodland (1983) first introduced the Kuhn-Tucker approach to estimate micro-level censored demand system. The Kuhn-Tucker approach derives demand (share) equations from maximizing an explicitly specified random utility function after incorporating non-negativity and budget constraints. But for some widely used demand systems such as the AIDS model, it is impossible to obtain an estimable empirical format accounting for non-negativity from utility functions (Dong and Kaiser, 2003). Heien and Wessells (1990) applied a two-step estimation procedure based on the Amemiya-Tobit approach to include all of the observations at both steps to estimate the equation. The Univariable Probit model is estimated for each equation in the demand system in the first stage, and in the second stage the inverse Mills Ratio is employed as an instrumented variable in a multivariable regression. However, statistical efficiency is compromised when the demand system is estimated with this procedure (Yen et al., 2004).

A simple but reasonable way to proceed in the case of censored data is suggested by Shonkwiler and Yen (1999) who develop a two-step estimator.

Consider the following censored system,

$$
\begin{aligned}
& w_{it}^{*} = f\left(\mathbf{x}_{it}, \boldsymbol{\beta}_i\right) + \varepsilon_{it}, \qquad d_{it}^{*} = z_{it}^{'}\boldsymbol{\alpha}_i + \upsilon_{it} \\
& d_{it} = \begin{cases} 1 \ \text{ if } \ d_{it}^{*} > 0 \\ 0 \ \text{ if } \ d_{it}^{*} \ \le 0 \end{cases} \qquad w_{it} = d_{it} w_{it}^{*} \\
& \left(i = 1,....,n, \ t = 1,....,T\right)
\end{aligned}
\tag{2}
$$

where $f(\mathbf{x}_{it}, \boldsymbol{\beta}_i)$ is in our case the right-hand side of the quadratic an ideal demand system (QUAIDS), which can be non-linear in $\boldsymbol{\beta}_i$ and censoring of each dependent variable is governed by a separate

stochastic process. For the i^{th} equation and t^{th} observation, w_{it} and d_{it} are the observed dependent variable, , w_{it}^{*} and d_{it}^{*} are corresponding latent variables, $\mathbf{x}_{it}$ and $\mathbf{z}_{it}$ are vectors of exogenous variables, , $\boldsymbol{\alpha}_i$ and $\boldsymbol{\beta}_i$ are vectors of parameters to be estimated, and ε_{it} and υ_{it} are random errors, which are assumed to be jointly distributed as a bivariate normal distribution with $\mathrm{cov}(\varepsilon_{it}, \upsilon_{it}) = \xi$. Accordingly, the unconditional mean of w_{it} is,

$$E\left(w_{it} \mid \mathbf{x}_{it}, \mathbf{z}_{it}\right) = \Phi\left(\mathbf{z}'\boldsymbol{\alpha}_i\right) f\left(\mathbf{x}_{it}, \boldsymbol{\beta}_i\right) + \xi_i \varphi\left(\mathbf{z}'\boldsymbol{\alpha}_i\right) \tag{3}$$

Using (3) combined with (1), the system of equations may be rewritten as

$$w_{it} = \Phi\left(\mathbf{z}'\boldsymbol{\alpha}_i\right) f\left(\mathbf{x}_{it}, \boldsymbol{\beta}_i\right) + \xi_i \varphi\left(\mathbf{z}'\boldsymbol{\alpha}_i\right) + \varsigma_{it} \tag{4}$$

where $\varsigma_{it} = w_{it-} - E\left(w_{it} \mid x_{it}, z_{it}\right)$. The two-step estimation procedure uses all observations and is as follows. Firstly, estimate parameters $\boldsymbol{\alpha}_i$ with probit using maximum likelihood to obtain $\hat{\boldsymbol{\alpha}}_i$. Next, calculate $\Phi\left(\mathbf{z}'\hat{\boldsymbol{\alpha}}_i\right)$ and $\varphi\left(\mathbf{z}'\hat{\boldsymbol{\alpha}}_i\right)$, the cumulative and density functions, and then use non-linear SUR in the second step to estimate $\beta_1, \cdots, \beta_n$ and $\xi_1, \cdots, \xi_n$ in the system,

$$w_{it} = \Phi\left(\mathbf{z}'\hat{\boldsymbol{\alpha}}_i\right) f\left(\mathbf{x}_{it}, \boldsymbol{\beta}_i\right) + \xi_i \varphi\left(\mathbf{z}'\hat{\boldsymbol{\alpha}}_i\right) + \varsigma_{it} \tag{5}$$

by maximum likelihood or iterative SUR.

3. Survey and Data Description

Survey Description

The data in the present study were collected by surveying urban households in Beijing in 2007, Nanjing in 2009, Chengdu in 2010, and Xi'an, Shenyang and Xiamen in 2011. Surveys in Nanjing and Chengdu were completed in September of the year, while they were conducted in July of the year in other cities.

The samples in our survey were selected by a stratified and random sampling approach from households participating in the Urban Household Income and Expenditure (UHIE) survey conducted by the National Bureau of Statistics of China (NBSC) in each city. As we mentioned earlier, the UHIE survey provides the primary official information on urban consumers' income and expenditures and is a primary data source of the published *China* Statistical *Yearbooks*. By using the subsample of UHIE, we have at least two objectives. First, we can able to compare our results to those from the UHIE survey to clearly understand the underestimated meat demand (Ma et al. 2004, Bai et al. 2010). Second, without the support from the NBSC local offices, it could be very difficult or even impossible to get access to urban households and obtain their consent to participate in the survey.

Several attributes make our survey data unique. First of all, all surveys were conducted through a diary-based recording approach. During the survey, we asked the sampled households to record all the detailed food consumption for all family members by meals. For food consumed at home, the recorded information includes each item's name, price, purchase venue, and amount consumed for that meal. For food consumed away from home, we recorded dish name, plane size, outlet format (including restaurants, fast food outlet, dining cafeteria, and other formats), each dish price, and total expenditures. For each occurrence of dining out, we also recorded information of diners through which we can easily link the diners to individual family member's demographics.

Second, all recorded dishes and processed and semi-processed foods consumed at home were then decomposed and converted into 79 kinds of commodity equivalents through a dish-to-commodity converting matrix. The matrix was mainly developed based on 135 different cooking books published in recently years and collected in survey cities. For dishes that could not be found in cooking books, we conducted a chef-survey to identify and estimate the components. A supermarket survey was also conducted in Beijing in 2008 to obtain component information for processed or semi-processed food items consumed at home. For meat consumption, our data includes pork, beef, mutton, poultry, edible

offal, and other meat products, such as donkey meat or rabbit meat. More detailed information about the data conversion is available upon request.

Third, in addition to the recorded dish information, the survey also collected detail information of household demographic and socioeconomic information, which allows us to link food consumption to these factors for further analysis.

Food away from home in our survey is defined to include almost all meals that are not prepared at home. According to this definition, all meals served in general restaurants, fast food outlets, cafeteria, and small vendor or stands where consumers or those who host the meal have to pay for (1) the ordered meals; (2) food preparation and service; and (3) any cost to provide dinning place and environment. The MAFH definition, however, rules out all food and food products that are purchased ready-to-eat from food stores, such as supermarkets, convenience stores, and some special food stores. Instead, these types of foods are treated as full-processed foods consumed at home although they are not prepared at home. A criterion to differentiate these foods from MAFH is whether the venue provides a dinning place for consumers to sit down and eat.

To improve data quality, a number of means were employed during the survey. First, the person who was most familiar with food shopping and food consumption in the household were asked to be a representative of the family to record food consumption for all family members. This procedure is able to generate more reliable data than random selection because these recorders normally play decisive roles in food expenditure and consumption activities in their households. Second, family representatives were given face-to-face explanation about the way to fill out the survey form, and demonstration from our enumerators by recording the meals which had been consumed on the day of dropping off. For example, if our enumerator went to the household in the afternoon, our enumerator will record breakfast and lunch by asking respondents to recall what they ate on the day. Third, during the survey week, enumerators were asked to call the surveyed respondents at least twice to answer any questions

and to provide a reminder. Fourth, the finished survey forms were carefully checked in front of the respondents when they were collected and by calling back in the following week. Fifth, two thirds of the enumerators involved in this survey were from the local branch of the NBS. These enumerators were mainly in charge of the UHIE survey and had good relationships with the households in the survey. Thus, their participation in our survey facilitated access to, and cooperation from the surveyed households. Sixth, each respondent was provided with a telephone card valued at 30 yuan (or about $4) so that the respondent could contact enumerators or survey leaders for any questions about the survey without cost, and they could also use the card to call their family members who eat separately from the respondent to learn what they consumed at work, school or elsewhere. Finally, the household received 100 yuan (or about $15) upon completion of the survey as an incentive.

4. Empirical Results

Descriptive Analysis

Urban households in the survey cities consumed a significant amount of meat, with some variations across cities and meat varieties though (Table 1). Chengdu tops at 7.31kg, followed by Beijing (6.02kg), Nanjing (5.93kg), Xiamen (5.09kg), Shenyang (4.75kg), and Xi'an (3.41kg). In terms of expenditure, the leading city is still Chengdu, with per capita monthly expenditure at 290.1yuan, followed by Nanjing (245.6yuan), Beijing (224.6yuan), Xiamen (195.0yuan), Shenyang (188.2yuan), and Xi'an (135.5yuan).

More importantly, meat consumed away from home accounts for a significant proportion in both volume and value. This is true for all of six cities. In terms of quantity, Xiamen leads other cities with 43% of total meat consumed away from home, while Beijing tops at 56% in terms of expenditure. More interestingly, if we only consider meat consumed at home, we see that per capita monthly/yearly pork consumption is about 2.18kg in Beijing, 2.28kg in Nanjing, 3.42kg in Chengdu, 1.22kg in Xi'an, 2.15kg in Shenyang and 2.50kg in Xiamen, which is about the same as the estimated level from the UHIE survey in

these cities correspondingly. This gives another evidence to say that dining out consumption was largely neglected in the UHIE survey, suggesting the importance to consider meat away from home when one studies meat consumption in China.

From meat type perspective, pork is consistently the most important livestock protein sources for people in all six cities. In quantity, pork consumption accounts for about 50% of total meat consumption in Beijing and Nanjing, while it is about 60% in other cities. In expenditure, per capita monthly spending on pork is more 100yuan in overall sample, which is about 48% of total expenditure on meat. Of which, pork at home is 28% and away from home is 20% (Table 2).

Table 2 also shows that there are significant proportion of households did not consume certain type of meat during the survey period. For example, the uncensored observation of pork consumption at home is 96%, meaning 4% of surveyed households did not consume any pork at home during the week. Meanwhile, about 20% of households did not dine out for pork. For beef or mutton, poultry, and other meat, the censored ratios are even higher. These reported zero consumption suggests the importance of methodology selection for demand system estimation.

Meat consumption is apparently related to household demographic and socioeconomic factors. First of all, meat consumption in overall is sustainably increasing with income growth. Excluding dining out meat consumption, however, will cause a misunderstanding of the relationship between income and meat consumption. Figures 1 through 3 presents per capita monthly meat consumption by meat variety and income in meat consumed in total, at home (MAH), and away from home (MAFH). Clearly, we saw that per capita total meat consumption is continuously increasing as income rises. The trend holds particularly for beef and poultry. For pork, however, we saw that per capita consumption reached the peak at the middle-income group and stagnated or slightly drop in the richest group (Figure 1).

However, income increases did not cause urban households to eat more meats at home, but encouraged them to dining out more for meat. From Figure 2, we can clearly see that the relationship between income growth and meat consumption is shaped as an inverse-U for MAH, that is, meat consumption at home is increasing with income at low income levels, but fall at higher income levels. The inverse-U can be seen in all meats except mutton which shows a decreasing trend with income growth.

On the contrary, meat consumption away from home clearly shows a sustainable and upwards trend as income grows (Figure 2). In particular, we see a sudden jump-up for dining out for pork, beef and poultry in the richest income group. A likely explanation for the shift is that income rising accompanied the increasing time opportunity cost to prepare meat-based foods at home and the rising demand for leisure and food services.

Literature often suggests that meat consumption or generally specking food consumption is related to family demographics. To find the demographic effects, we first grouped the surveyed families into seven types based on members' age (Table 3).

Apparently, family composition matters in terms of meat consumption. For example, families consisting of only middle age members (31~55 years old) consume the highest quantity of meat (7.5kg) while families consisting of only elders (55 years old or up) consume the lowest quantity of meat (5.4kg). As expected, other families mixed with two or three generations are consuming an amount that is between the highest quantity by the middle aged families and the lowest by the elder families. Meanwhile, it is noted that families with only youths consumed more meat away from home than all other types of families, while for families with only elders dining out meat consumption accounts for only 15%, being at the bottom among these seven types of families.

The presence of children or elders in a family also affects meat consumption. To investigate the effects, we grouped all surveyed families by whether they have children below 12 years old and elders above 55 years old. The results in Table 5 show that families having child(ren) consume 5.95kg of meat a month per person, while in families without children it is 6.39kg or 0.44kg lower. The senior effect could be higher. For families with senior(s), per capita meat consumption is 5.83kg a month, which is 0.9kg lower than that for families without senior.

By looking at all meat varieties, we find that elders consistently have more negative effects on family meat consumption than children do (Table 4). It is specifically true for pork, beef and poultry, three primary meats in China. It is still not clear whether people are going to eat less meat when they become elderly or these elders we observed in the surveys are consuming less than youths did but is already higher than that they consumed when they were young. If it is the former, our findings indeed suggest that the effect on meat demand is negative when the society in China is aging, holding other effects unchanged. But if it is the latter, the effect could be positive or at least not negative.

Empirical Results

To empirically investigate the role of dining out consumption on meat expenditure and own-price elasticities, we estimate two systems. In the first system, we include eight meat categories, including pork, beef and mutton, poultry, and other meat consumption at home, and pork, beef and mutton, poultry, and other meat away from home. By doing so, we actually assume that meat at home and away from home are two separable goods. In the second system, we only include four food categories consumed as home in the system. Then the estimated results and elasticities can directly be used to reveal the role of MAFH inclusion in the demand system. In both systems, we include two demographic variables and five cities dummies. The two demographic variables are: senior, which takes the value of one if the household has any member who is aged 60 years old or above, and zero otherwise, and

number of wager in the household. The five cities dummies are included to control any possible regional variation of meat consumption.

Based on estimated results from each system, we calculate the expenditure and own-price elasticities at the sample means of the explanatory variables in order to evaluate the effects of total expenditure and prices. The expenditure elasticities and unconditional own-price (Marshallian) elasticities from two systems are presented in Table 5. For statistical inference, we applied bootstrap method with 1,000 iterations to estimate the standard errors for these elasticities. It is clear that all expenditure and own-price elasticities are significantly different from zero at the 1% level, without any exception.

The comparison of the estimated expenditure and own-price elasticities suggests that excluding meat consumption away from home could bias these elasticities upwards in magnitude. For example, expenditure elasticity for pork at home is 0.676 if we consider away from home in the system, but it is 0.871 in the reduced four-equation system. For beef and mutton, the upward bias is even more, with expenditure elasticity being 0.936 in 8-eq system and 1.408 in 4-eq system. Later on, our discussion will mostly focus on the results from the eight-equation system.

From Table 5, one can clearly see that the estimated expenditure elasticities are all positive and significant at the 1% level, suggesting that all meats considered both at home and away from home are normal goods.

The expenditure elasticities are corresponding higher for meat away from home than those at home, which suggests that with total meat expenditure increases urban households in China tend to increase spending on meat away from home more than that on meat at home. Also, for meat at home, the expenditure elasticity for poultry is considerably high, at 1.239, which makes poultry the only meat at home having expenditure elasticity greater than unity. For meat away from home, four types of

meats are all considerably higher than unity. Among them, other meat category—mainly including specific meat such as donkey meet, rabbit meat and other non-traditional meat, has the highest expenditure elasticity (1.887), followed by beef and mutton (1.624), poultry (1.601), and pork (1.129).

These expenditure elasticities have important marketing implications. With China's rapid economic growth, household disposable income has also significantly increased over the last near three decades, and real income is expected to continue to grow with a remarkable high growth rate. As a result, household expenditures for meat consumption are expected to increase as well, probably with an increasing rate higher than ever. Our estimated expenditure elasticities suggest that the most substantial increase will happen away from home rather than at home. Meanwhile, household expenditure on poultry at home and all four categories of meats away from home will increases more than proportionately to total expenditure on meat. On the contrary, it will be less than proportionately to the total meat expenditure for pork, beef and mutton, and other meat at home.

The significantly positive expenditure elasticities also have important implications for domestic agricultural production and international trade, especially for feed grain such as corn and soybean meal. China's livestock production has grown rapidly in response to higher consumer demand. Our estimated elasticities indicate that the rapidly increasing from demand side will continue to bring pressure on China's domestic meat production. Despite China has achieved incredible successes in keeping a relative high self-sufficient rate for most agricultural commodities so far, a big question is whether China will continuously be success and stay in a comfortable position to meet the challenges from the rapidly shifting diet from one centered at staple foods to one incorporated with more livestock protein such as meat. Our findings from this study suggest that the challenge could be more severe than what most people expected if we take meat consumption away from home into consideration.

The estimated unconditional own-price elasticities (Marshallian) are expectedly negative and significantly at the 1% level, which tell a number of interesting stories. First, price elasticities for meat away from home are correspondingly higher than those at home. In other words, meat consumption away from home is more price-responsive than meat purchased for home consumption. Second, among four types of meat, beef and mutton have the highest price elsticitiy both for at home and away from home consumption, being at -1.266 and -1.310, respectively, which means that one percent of price decrease could cause more than one percent of household expenditure on beef and mutton both at home and away from home, suggesting a price reduction could be an effective way to promote beef and mutton market. Contrary to beef and mutton, poultry consumption both at home and away from home is less responsive to price change.

The cross-price elasticities reflect the complement or substitute relationships among these meat categories. From Table 6, it's clear that more than half of cross-elasticities are statistically significant at the 1% level, several at the 5% or 10% levels. While it is not easy to discern a clear pattern among these elasticities, there are two stable results easy to see. First, all four types of meats consumed away from home are significant substitutes for pork at home. In other words, meat price away from home increase could cause pork consumption at home significantly increases. Second, meats away from home are complements to each other, suggesting dining out price increase for any meat could not only cause its own consumption away decrease, but also shrink other dining out meat consumption as a group. This is reasonable because intuitively any meat price increase could reduce the likelihood of dining out for households. Third, within MAH group, it is easy to see that pork consumption is significantly and positively related to prices of beef and mutton, and other meat, but negatively related to price of poultry. This means that poultry is beef and mutton and other meats at home are substitutes for pork at home, while poultry is complement for pork.

5. Conclusions and Implication Discussion

With rapidly shifting of diet in urban China drove by its dramatic economic growth and urbanization, analyzing meat demand in the country has important implications for understanding domestic food market and international trades for agricultural commodities. In this study, we jointly consider meat consumed as home and away from home by using our own survey data from six cities which have remarkable regional or even national influences. We investigate the roles of including meat away from home in consideration in a comprehensive understanding of meat demand in China.

We found that urban household expenditure elasticities on meat away from home are consistently higher than those eaten at home. This finding does not only suggest that meat consumption away from home could increase more than proportionately to total meat expenditure, but also indicate that excluding MAFH could misleading one's understand of meat consumption trend in China and its implications for domestic supply and international trade.

We also found that expenditure elasticities vary across meat category, but all significantly positive. This suggests that income is a critical driving force of the increasing meat demand and structure changes. Meanwhile, the finding also suggests that the consumption of beef and mutton, and poultry will grow at a relative high rate than pork.

Regarding price effects, we found that dining out for meat consumption is more responsive to price related to meat purchased for home consumption. Within meat consumption at home, however, we found that beef and mutton and other meat are substitutes for pork while poultry is complement for pork. Differently, meats consumed away from home are complements to each other. One reasonable explanation is that when price of one type of meat increases, Chinese urban households will just simply cut down their frequency of dinning out rather than shifting to other meats when they eat out.

References:

Bai, J., Wahl, T., Lohmar, B., and Huang, J. 2010. Food away from home in Beijing: effects of wealth, time and "free" meals. *China Economic Review,* 21(3): 432-41.

Byrne, P. J., Capps, O., and Saha, A. 1996. Analysis of food-away-from-home expenditure patterns for US households, 1982-89. *American Journal of Agricultural Economics,* 78(3): 614-27.

Dong, F. X. and Fuller, F. 2010. Dietary Structural Change in China's Cities: Empirical Fact or Urban Legend? *Canadian Journal of Agricultural Economics-Revue Canadienne D Agroeconomie,* 58(1): 73-91.

Fan, S. G., Wailes, E. J., and Cramer, G. L. 1995. Household demand in rural China: A two-stage LES-AIDS model. *American Journal of Agricultural Economics,* 77(1): 54-62.

Gao, X. M., Wailes, E. J., and Cramar, G. L. 1996a. Partial Rationing and Chinese Urban Household Food Demand Analysis. *Journal of Comparative Economics,* 22(1): 43-62.

Gao, X. M., Wailes, E. J., and Cramer, G. L. 1996b. A two-stage rural household demand analysis: Microdata evidence from Jiangsu Province, China. *American Journal of Agricultural Economics,* 78(3): 604-13.

Guo, Z., Mroz, T. A., Popkin, B. M., and Zhai, F. 2000. Structural Change in the Impact of Income on Food Consumption in China, 1989-1993. *Economic Development and Cultural Change,* 48(4): 737-60.

Huang, J., Rozelle, S., and Rosegrant, M. W. 1999. China's Food Economy to the Twenty-first Century: Supply, Demand, and Trade. *Economic Development and Cultural Change,* 47(4): 737-66.

Ma, H., Huang, J., Fuller, F., and Rozelle, S. 2006. Getting Rich and Eating Out: Consumption of Food Away from Home in Urban China. *Canadian Journal of Agricultural Economics-Revue Canadienne D Agroeconomie,* 54: 101-19.

Ma, H., Huang, J., and Rozelle, S. 2004. Reassessing China's Livestock Statistics: An Analysis of Disrepancies and the Creation of New Data Series. *Economic Development and Cultural Change,* 52(2): 445-73.

Min, I., Fang, C., and Li, Q. 2004. Investigation of patterns in food-away-from-home expenditure for China. *China Economic Review,* 15(4): 457-76.

Mutlu, S. and Gracia, A. 2006. Spanish food expenditure away from home (FAFH): by type of meal. *Applied Economics,* 38(9): 1037-47.

Shonkwiler, S. J. and Yen, S. T. 1999. Two-Step Estimation of A Censored System of Equations. *American Journal of Agricultural Economics,* 81(November): 972-82.

Wang, Z. and Chern, W. S. 1992. Effects of rationing on the consumption behavior of Chinese urban households during 1981–1987. *Journal of Comparative Economics,* 16(1): 1-26.

Zhong, F. N. 1997. Exaggeration and Causes of Meat Production Statistics Overreporting in China. *Chinese Rural Economy*: 63-66.

Table 1. Per capita monthly meat consumption (Kg/person) and expenditure (Yuan/person)

	Beijing		Nanjing		Chengdu		Xi'an		Shenyang		Xiamen	
	Amount	% of MAFH	Amount	% of MAFH	Amount	% of MAFH	Amount	% of MAFH	Amount	% of MAFH	Amount	% of MAFH
By Quantity												
Pork	3.07	0.29	2.98	0.23	4.31	0.21	2.14	0.42	2.91	0.26	3.16	0.21
Beef & Mutton	1.12	0.33	0.65	0.37	0.69	0.33	0.55	0.58	0.78	0.31	0.40	0.38
Poultry	1.47	0.42	1.82	0.21	1.62	0.30	0.57	0.33	0.77	0.36	1.02	0.31
Other Meat	0.35	0.47	0.47	0.25	0.69	0.08	0.15	0.43	0.28	0.55	0.52	0.25
Total	6.02	0.34	5.93	0.24	7.31	0.23	3.41	0.43	4.75	0.30	5.09	0.24
By Expenditure												
Pork	94.8	0.44	101.8	0.46	142.0	0.39	70.8	0.47	112.1	0.39	105.2	0.27
Beef & Mutton	56.4	0.62	47.1	0.59	40.2	0.56	31.2	0.67	40.9	0.45	25.7	0.56
Poultry	56.1	0.66	77.9	0.57	68.6	0.46	25.9	0.59	24.6	0.58	39.5	0.37
Other Meat	17.4	0.72	18.8	0.55	39.3	0.43	7.7	0.58	10.5	0.69	24.5	0.44
Total	224.6	0.56	245.6	0.53	290.1	0.44	135.5	0.55	188.2	0.44	195.0	0.35

Table 2. Expenditure shares and proportion of uncensored observation

	Expenditure	Share	% of uncensored
MAH			
Pork	61.1	0.28	0.96
Beef&Mutton	17.7	0.08	0.46
Poultry	22.6	0.10	0.65
OtherMeat	8.8	0.04	0.37
MAFH			
Pork	42.3	0.20	0.80
Beef&Mutton	24.7	0.11	0.54
Poultry	27.9	0.13	0.60
OtherMeat	10.5	0.05	0.33
Total	215.5	1.00	

Table 3. Description of Family Type Grouping

Family Type	Description	Age Range
Yhh	family with only young members	Age<=30 years old
Mhh	family with only middle age members	31<Age<=55 years old
Ehh	family with only elder members	Age>55 years old
Ymhh	family mixed by young and middle age members	
Yehh	family mixed by young and elder members	
Mehh	family mixed by middle age and elder members	
Ymehh	family mixed by young, middle age and elder members	

Table 4. Children and Senior Effects on Meat Consumption

	Child(ren)			Senior(s)		
	No	Yes	Diff	No	Yes	Diff
Pork	3.38	3.28	-0.10	3.50	3.20	-0.30
Beef	0.72	0.62	-0.10	0.81	0.57	-0.24
Mutton	0.17	0.11	-0.07	0.19	0.13	-0.06
Poultry	1.64	1.51	-0.12	1.74	1.47	-0.27
Edible Offal	0.42	0.39	-0.04	0.44	0.39	-0.05
Others	0.07	0.05	-0.02	0.05	0.07	0.02
Total	6.39	5.95	-0.44	6.73	5.83	-0.90

Table 5. Estimated cross-price elasticities

		MAH				MAFH			
		MAF				MAFH			
		Pork	Beef&Mutton	Poultry	Other meat	Pork	Beef&Mutton	Poultry	Other meat
MAH	Pork	-0.814 ***	1.149 ***	-0.321 **	1.916 ***	0.242 ***	0.517 ***	0.691 ***	1.139 **
		(0.02)	(0.19)	(0.12)	(0.26)	(0.06)	(0.15)	(0.15)	(0.45)
	Beef&Mutton	0.079 ***	-1.266 ***	-0.063	-1.144 ***	0.019	-0.164	-0.118	-1.121 ***
		(0.02)	(0.13)	(0.09)	(0.23)	(0.05)	(0.14)	(0.12)	(0.36)
	Poultry	-0.105 ***	0.297 *	-0.453 ***	-0.162	-0.009	0.16	0.068	0.503
		(0.03)	(0.16)	(0.07)	(0.22)	(0.06)	(0.15)	(0.13)	(0.42)
	Other meat	0.021	-0.637 ***	-0.399 ***	-0.623 ***	-0.031	-0.357 ***	-0.286 ***	-1.362 ***
		(0.02)	(0.13)	(0.07)	(0.19)	(0.04)	(0.12)	(0.1)	(0.33)
MAFH	Pork	-0.029	-0.004	-0.305 ***	-0.041	-0.998 ***	-0.483 ***	-0.758 ***	-0.949 ***
		(0.02)	(0.1)	(0.06)	(0.15)	(0.06)	(0.11)	(0.09)	(0.32)
	Beef&Mutton	0.039 **	-0.005	0.005	-0.192	-0.117 ***	-1.31 ***	-0.222 **	-0.199
		(0.02)	(0.08)	(0.06)	(0.15)	(0.04)	(0.13)	(0.09)	(0.29)
	Poultry	0.085 ***	0.171 *	0.067	0.254 *	-0.151 ***	-0.019	-0.878 ***	0.155
		(0.02)	(0.1)	(0.07)	(0.15)	(0.05)	(0.11)	(0.12)	(0.32)
	Other meat	0.037 **	-0.13	0.083 *	-0.246 **	-0.006	0.024	-0.049	-1.014 ***
		(0.02)	(0.08)	(0.04)	(0.12)	(0.04)	(0.08)	(0.07)	(0.27)

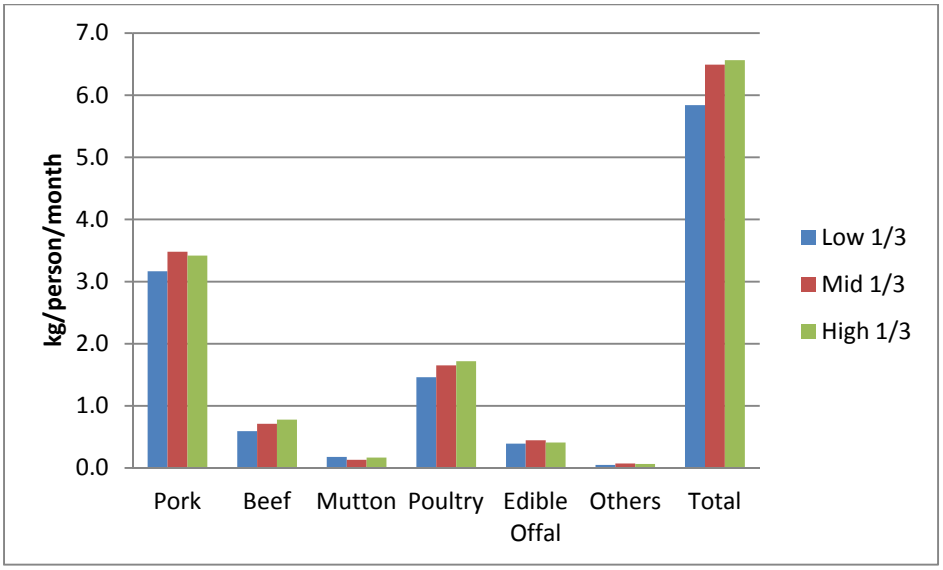

Figure 1: Per Capita Meat Consumption in Total

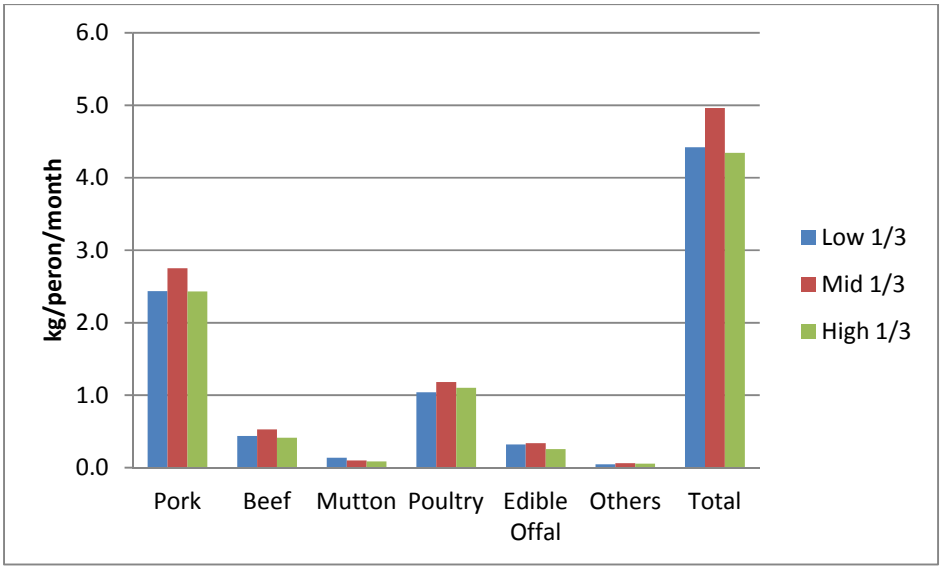

Figure 2: Per Capita Meat Consumption at Home (MAH)

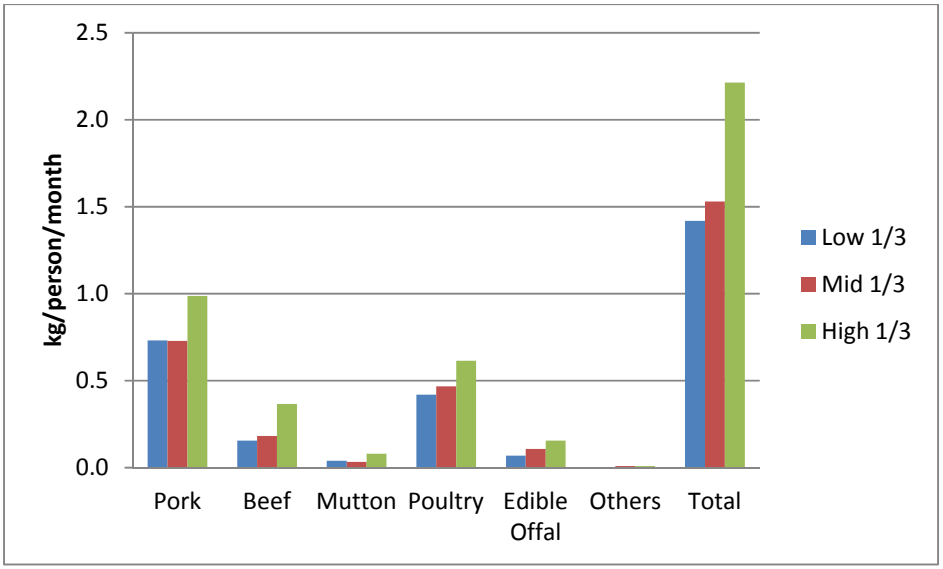

Figure 3: Per Capita Meat Consumption Away from Home (MAFH)

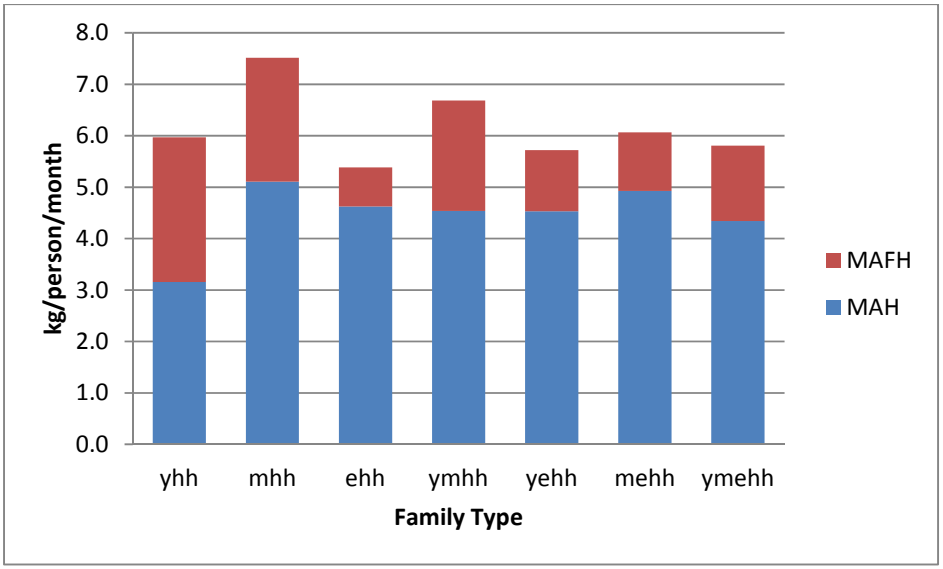

Figure 4: Per Capita Meat Consumption and Venue Choice Differ by Family Composition